UNCLASSIFIED

AD NUMBER AD103229 CLASSIFICATION CHANGES TO: UNCLASSIFIED FROM: CONFIDENTIAL LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Gov't. agencies and their contractors;

Administrative/Operational Use; 06 MAY 1956. Other requests shall be referred to Office of Naval Research, Arlington, VA 22203.

AUTHORITY

ONR ltr 28 Jul 1977 ; ONR ltr 28 Jul 1977

THIS REPORT HAS BEEN DELIMITED

AND CLEARED FOR PUBLIC RELEASE

UNDER DOD DIRECTIVE 5200.20 AND

NO RESTRICTIONS ARE IMPOSED UPON

ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

UNCLASSIFIED

AD____

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION ALEXANDRIA, VIRGINIA

DOWNGRADED AT 3 YEAR INTERVALS: DECLASSIFIED AFTER 12 YEARS DOD DIR 5200 10



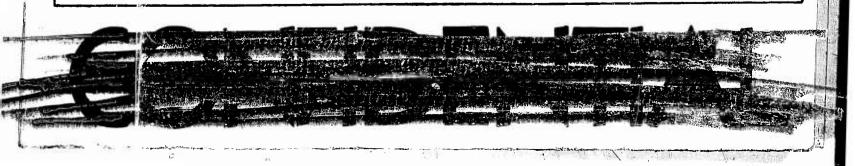
UNCLASSIFIED



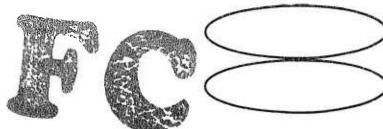
Reproduced by DOCUMENT SERVICE CENTER KNOTT BUILDING, DAYTON, 2, OHIO

This document is the property of the United States Government. It is furnished for the duration of the contract and shall be returned when no longer required, or upon recall by ASTIA to the following address: Armed Services Technical Information Agency, Decument Service Center, Knott Building, Dayton 2, Ohio.

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

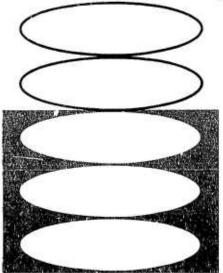


Best Available Copy



ENGINEERING REPORT NO.





AERODYNAMIC ANALYSIS REPORT
TRANSPORT PROPELLOPLANE STUDY
Contract Nonr 1657(00)



AUG 2 = 1958

EGAA 46991 /-457

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794.

THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

HILLER HELICOPTERS

PALO ALTO, CALIFORNIA

ENGINEERING REPORT

	REPORT NO. 114.7	
	MODEL NO. 1048	
TITLE	AERODYNAMIC ANALYSIS REPORT FOR TRANS	SPORT
	PROPELLOPLANE STUDY - CONTRACT NONR 10	557 (00)
NO. OF FA	058 <u>41</u>	DATE May 4, 1956
This down	11). C. + ort.	ASSISTED BY M. B. Honde CHECKED R. Horda R. Herda APPROVED R. Carlson APPROVED W. Wiesne
	Cities of animal has arch (Cod 461) REVISIONS	for R. Wagner
DATE	PASE NUMBER	
ONE THE	Acceptance -	

FORM 60.030 A

56AA 46991

PREPARED (15 COLD)	LATE on pin ()	HILLER HELICOPTERS	PAUL
SHECKED	pur un i Manugen i	Transport Propelloplane study	MODEL ICH
APPROVED		Contract Nour 1657 (60)	REPORT NO 111,07

The state of the s

INDEX

		Page No.
1.0	SUMMARY	1
2.0	GENERAL CONSIDERATIONS AND ASSUMPTIONS	3
3.0	SPECIFIED AIRCRAFT PERFORMANCE AND MISSION REQUIREMENTS	27
4.0	MATRIX	32
5.0	MODEL 1048-A, OPTIMUM AIRCRAFT	32
6.0	MODEL 1048-B	36
7.0	MODEL 1048-D	39



PREPARED N	MANE	CATE	HILLER HELICOPTERS	PATE
CHECKED		T+* LE	A rodynamic Activs: Report for Transport Propelloplane Study	MI CO LOT C
APPROVED			Contract Long 1047 (00)	REPORT NO

SYMBOL5

AF - Propeller Activity Factor

AR - Geometric Aspect Ratio of Aircraft Wing = $\frac{b^2}{5}$

F - Number of Propeller Blades

b - Wing Span - Feet.

D - Drag, Pounds

Dp ... Propeller Diameter, Feet.

e - Oswalds Equivalent Aircraft Span Efficiency Factor

F - Fuel, Pounds

f - Equivalent Parasite Drag Area, ft²

H - Altitude, Feet

K - Constant

N - Number of Propellers

MRP - Normal Rated Power, Shaft Horsepower

QT - Thrust Coefficient

R - Range, Nautical Miles

R/C - Rate of Climb, FPM

R/D - Rate of Descent, ft. per minute.

RF - Fuel Weight/Gross Weight

S - Wing Area - Square Feet

SHP - Shaft Horsepower

 $T_{\mathbb{C}}$ - Torque Coefficient

TMPa - Thrust Horsepower Available, = T x V

PREPARLO	NAME	DAIL	HILLER HELICOPTERS	PAGE	
CHECKED	gently are now u.s. in the second or effective some	with the same of the shown is to the same	Transport Propollonlane Study	MODEL (1), 8	
APPROVED	MAN W1 .		Contract Monr 1657 (60)	REPORT NO. 114	0 1

SYMBOLS

THPr - Thrust Horsepower Required

V - Velocity, Nautical Miles per Hour, True Air Speed.

v - Velocity, FPS

 V_{T} -- Propeller Tip Speed - FPS

 $- \text{ Disk Loading, lbs/sq.ft.} = \frac{W_G}{N \pi DP^2}$

WG - Airplane Weight, Pounds

 W_{H} - Thrust Loading, lbs/sq.ft. = $\frac{\text{Sea Level Static Thrust}}{\text{Propeller Disk Area}}$

η ~ Propeller Efficiency

 ρ - Mass Density of Air, Slugs/ft³

SUBSCRIPTS

A - Refers to Engine A

a - Available

B - Refers to Engine B

c - Climb

d - Descent

e - Engine

F - Fuel

PREPARED	HANE	DATE	HILLER HELICOPTERS	PAUL
CHECKLD			Transport Pro Plantage of g	MODEL
APPROVED		,	Contract Lour 1997 (29)	REPORT NO 1 1 16

SUBSCRIPTS

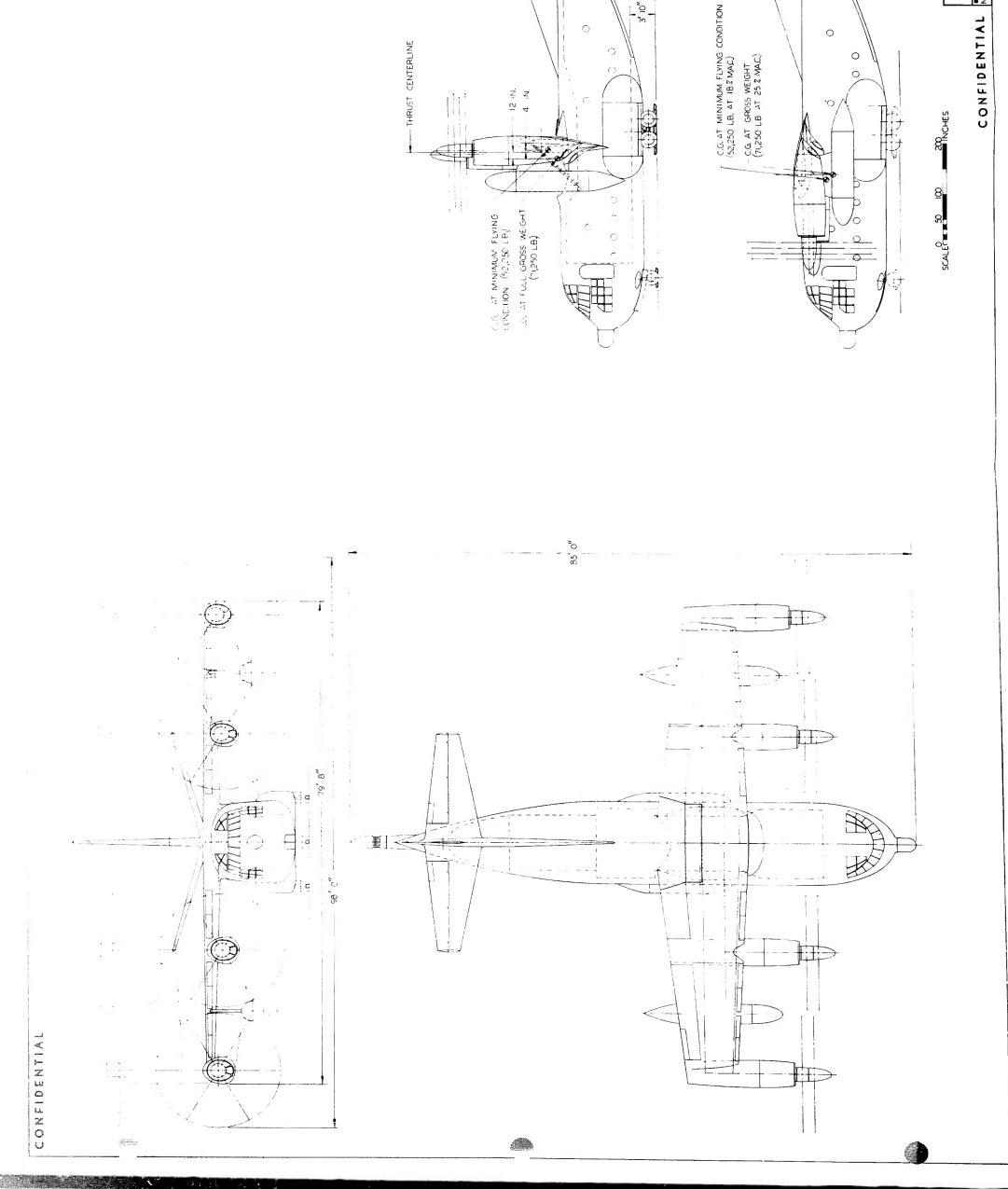
- G -- Gross
- : Inboard
- O Standard Sea Level or Outboard
- P Propeller or Propeller Shaft
- R Required
- T Tip
- 8 8 Engine or Total

PREPARED Wa T	AME CATE OUT THE CO	HILLER HELICOPTERS	PA(, F
CHECKED		THEE Aerodynamic Analysis Report For	MODEL
-	i	Trangert Propolloplane Study	Account to the second s
APPROVED		Contract Nonr 1657 (00)	REPORT NO 11407

1.0 SUMMARY

This report provides an aerodynamic analysis and outlines methods used in obtaining the aerodynamic "RF" for the solution of the optimum transport propelloplane under contract Nonr 1657 (00). The combination of aerodynamics and weights "RF" (Reference 2) by the method described in Reference 1 yielded the optimum aircraft.

Minimum gross weight was considered to be the criterion for optimum selection. A three view drawing of the optimum aircraft is provided on the following page.



 \circ

Hiller Helicopters

0

0

GENERAL ARRANGEMENT

SOLE DARWIN HOBART DATE 4-4-56 | 1048A-001

PREFARED .	, A . 4	HILLER HELICOPTERS	
CHECKED		Transport Provile come of	
APPROVED		Contract Monr (o (-)	REPORT NO 111.

2.0 ENERAL CONSIDERATIONS AND ASSUMPTIONS

2.1 Engine Characteristics

Generalized shaft turbine engine characteristics according to Reference 3 for the year 1965 were used. Specific fuel consumption versus % NRP curves are repeated in Figure 2 for easy reference.

The contribution of turbine jet thrust to forward flight propulsion was not considered, since its effect was small at the flight speeds encountered and insignificant on a comparative basis as affecting the optimum selection.

2.2 Gear Box "Derating"

As a result of the gear boxes being derated, the power output per two engine combination is limited to 75 percent of sea level NRP.

2.3 Drag

The equivalent parasite drag area, f, was computed to be 41.2 ft^2 in cruise configuration with external fuel tanks. This value was assumed constant for the matrix of possible aircraft considered.

2.4 Power Required

Airplane thrust horsepower required is defined by the following expression:

$$THP_{r} = \frac{\frac{\rho}{\rho_{o}} \text{ V}^{3} \text{ f}}{96100} + \frac{\text{Wg}\left(\frac{\text{Wg}}{\text{S}}\right)}{3.47 \text{ AReV } \frac{\rho}{\rho_{o}}}$$

Let K =
$$\frac{W_G\left(\frac{W_G}{S}\right)}{3.47 \text{ ARe}}$$
 (1)

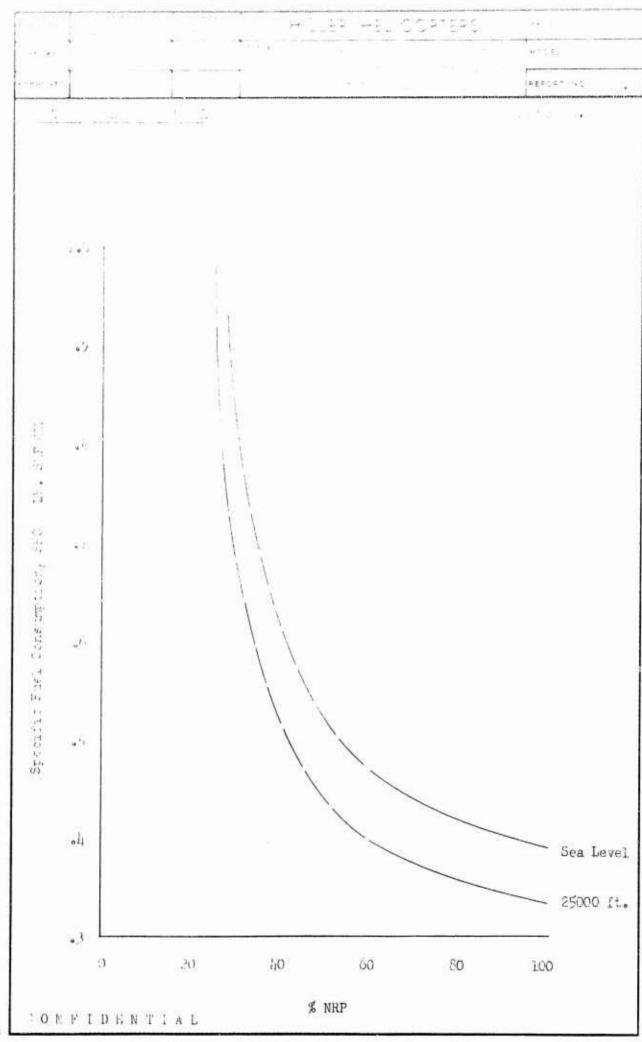
$$f = 41.2 \text{ (see 2.3), then}$$

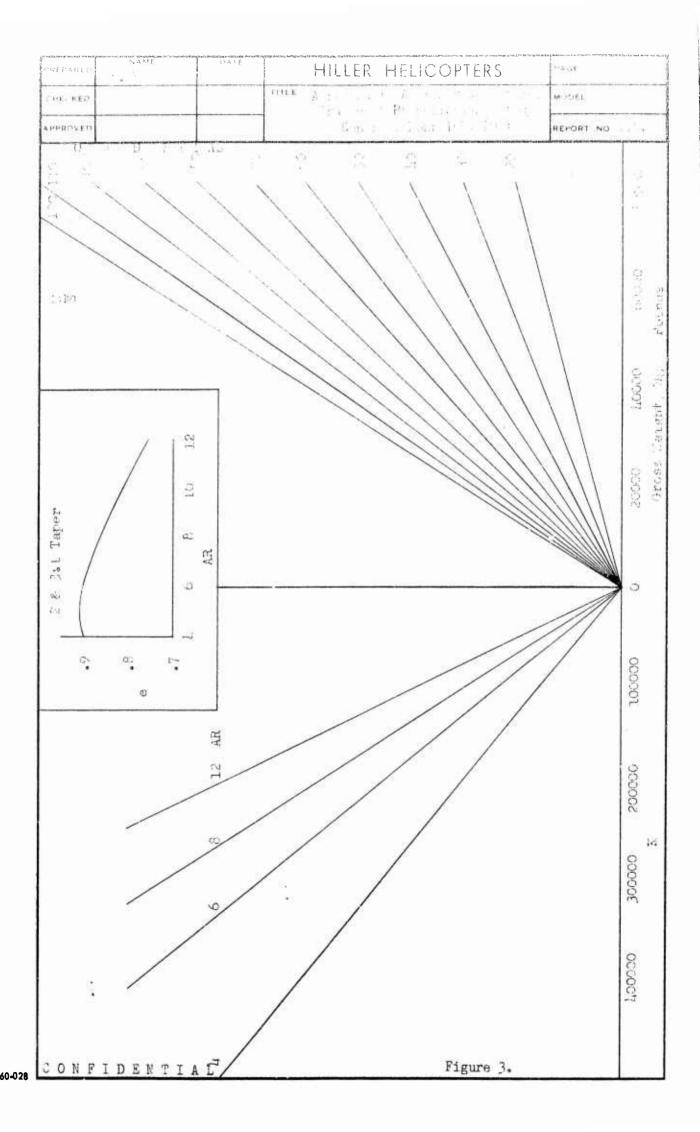
$$THP_{r} = \frac{\frac{\rho}{\rho_{0}} v^{3}}{2330} + \frac{K}{\frac{\rho}{\rho_{0}} v}$$
 (2)

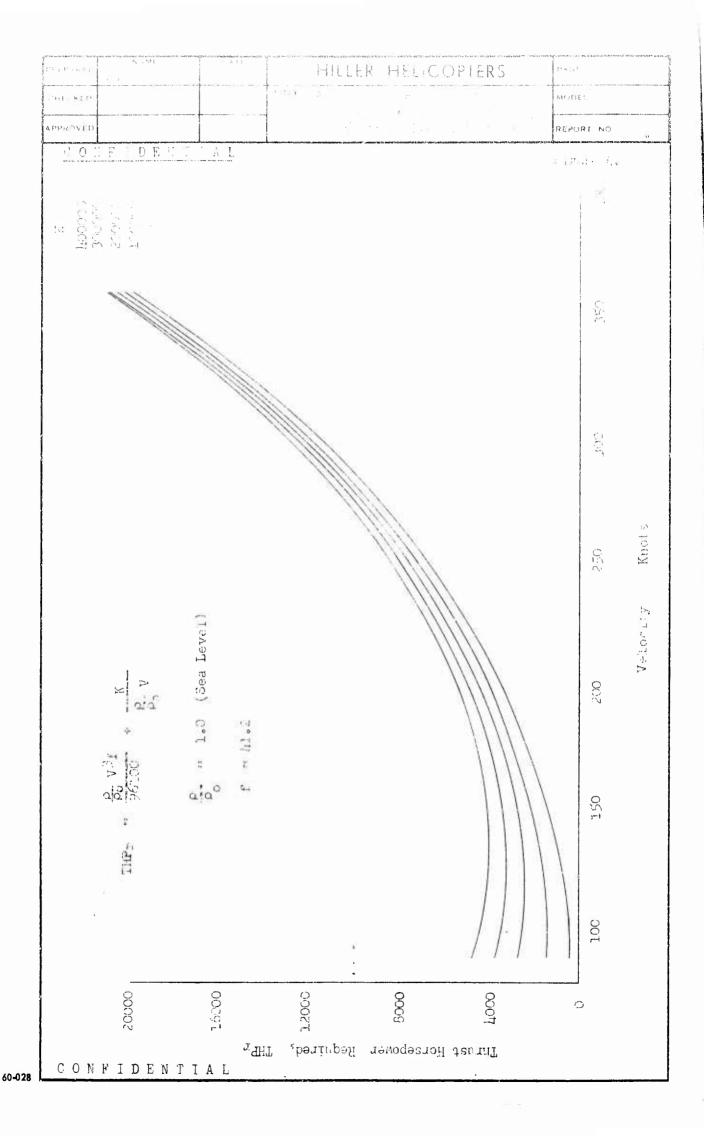
DIRECTOR	W. Jan	A STATE OF THE PARTY OF THE PAR	ρΔ' ξ
CHECKED		Transport Propelloplane Study	MODEL 10/16
APPROVED		Contract Nonr 1657 (00)	REPORT NO 114.7

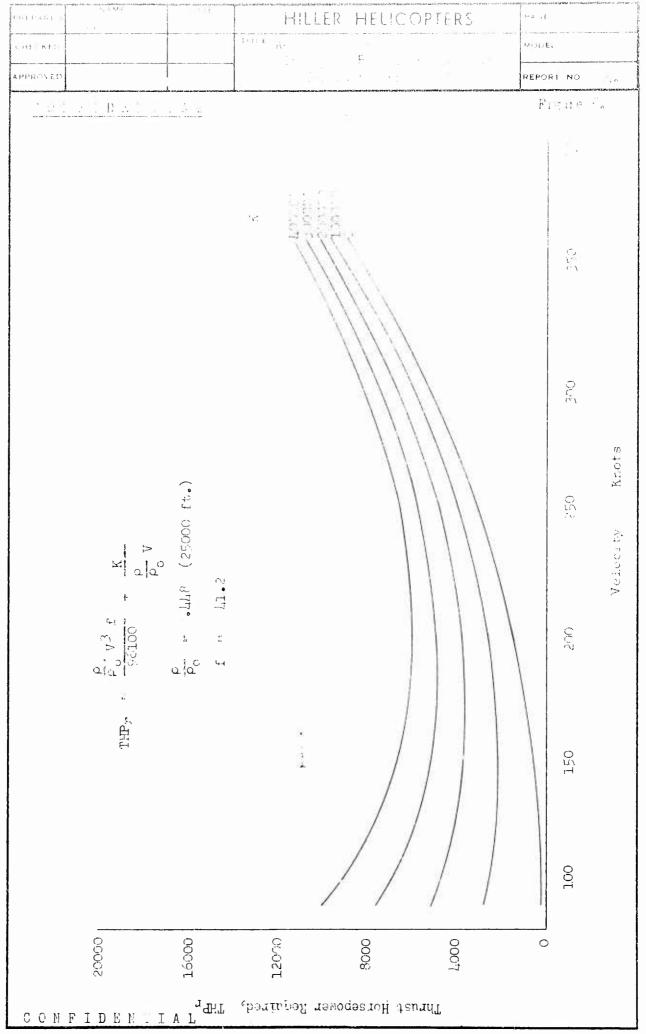
2.4 Power Required (Continued)

Equations (1) and (2) are plotted on the following pages (Figures 3, 4, and 5) permitting the solution of THP_r for selected values of ρ/ρ_0 , V, WG, WG/S, and AR. Figure 6 shows the assumed variation of e with AR, being reproduced from Reference 4.









	NAME	ITAIL		
BREPARED			HILLER HELICOPTERS	PAGE ,
CHECKED			THE Aerolamonic Analysis Report For	MODEL 1.118
			fransport Propelloplane Study	
APPROVED			Contract Nour 1647 (00)	PEPDAT NO. 11/1.7

というないというのであるというできます。

2.5 Power Available

In order to describe the available thrust horsepower characteristics of an aircraft, the following must be known.

- 1. Installed Horsepower
- 2. Propeller Diameter.
- 3. BAF
- 1. Tip Speed
- 5. Altitude
- 6. Type of Propeller, i.e. Single or Dual Rotation
- 7. Propeller Characteristics, i.e. Variation of Propeller Efficiency with Forward Speed.

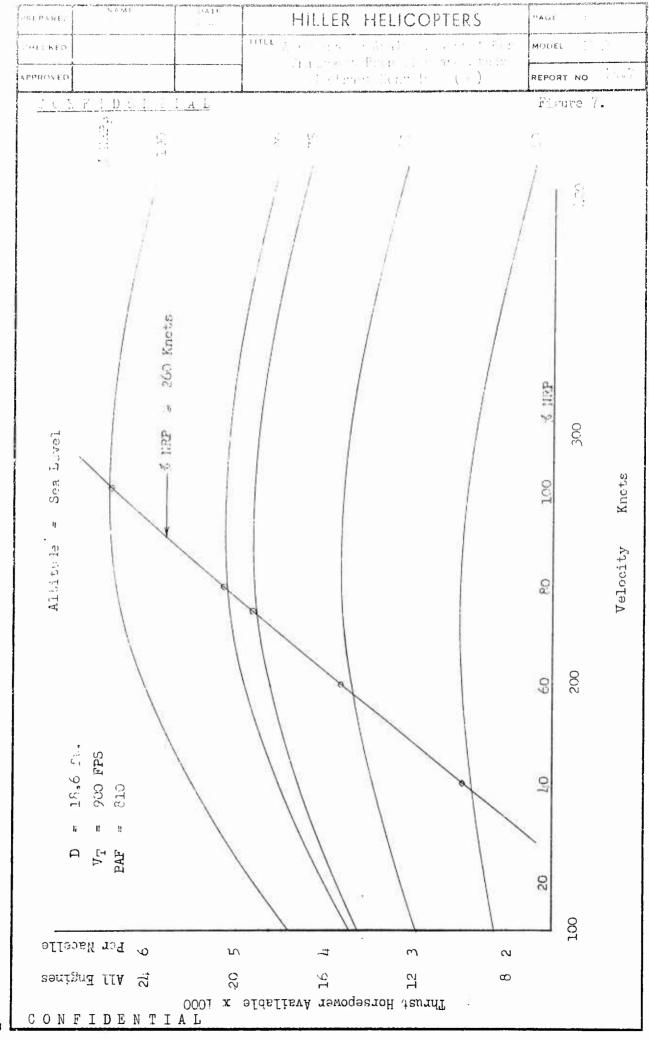
Items 1-3 were obtained on the basis of the 6000' 95°F hover ceiling requirement and minimum power package weight. A complete discussion of this is contained in Reference 2.

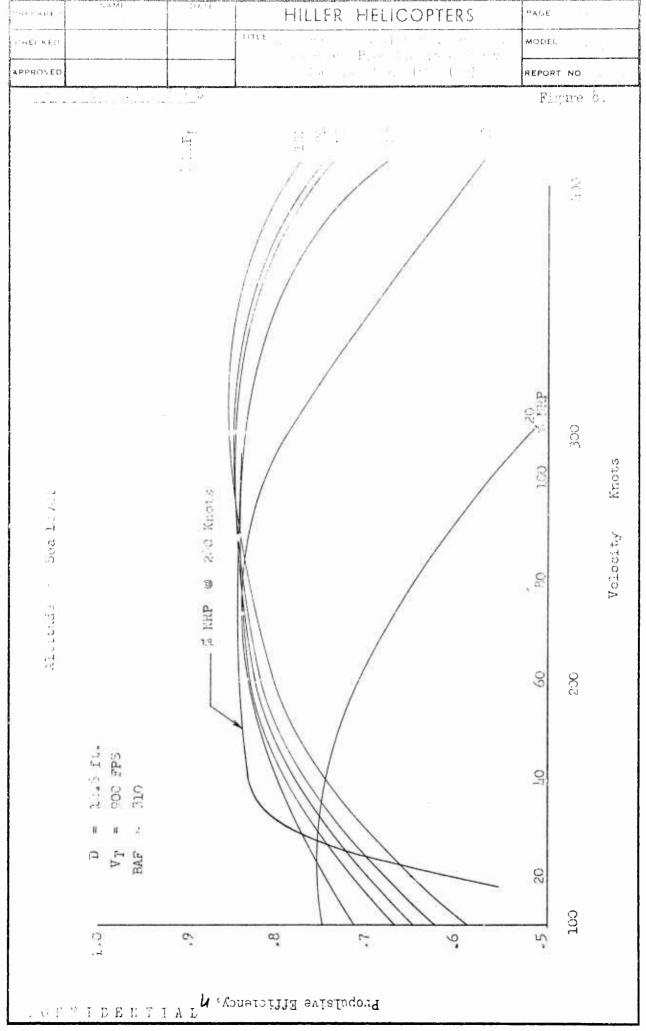
Items 4-5 Variables.

Item 6 Dual rotating propellers were used.

Propeller characteristics were obtained from
Reference 5.

For purposes of illustration, Figures 7 through 10 show the variation of propeller efficiency and thrust horsepower with forward flight velocity at various percentages of shaft horsepower for the optimum aircraft (Figure 1).





PRIPARED	1 V 1 L				OPTERS	"A", É	1.1	
CHECKEU						MODE	i	,
(PPROVED		. 1	Contra	et honr	1977 (19)	REPOR	T NO	(1)
e c l V I D i	(1.	S S	3 L	7	9	Fig	ure	9.
		207' Knots					Out:	
25000 ft.		S NRP 2				100 % NRP	300	Knots
Altitude =						80	, ž	Velocity
•						09	200	
D = 15.6 ft. VT = 900 FPS				/		01/		
T Nacelle		m		~		0 20	100	
confide	NTIVF OOOLx 91	r Availab		oh teuad e		0		

1

DHENNED	N. V. C.	ATL may are ()	HILLER HELICOPTERS	PAGE 171
CHECKED		1	Transport Propallandara Study	марес 1047
APPROVEO			Transport Propelloplane Study Contract Nonr 1057 (00)	REPORT NO 114.7

2.6 Engine Operation

The transport propelloplane under consideration provides for a total of 8 engines and 4 nacelles (2 engines per nacelle). When cruising at less than full power, a number of possible operating combinations exist. It is the object of this section to determine a schedule of engine operation which will require the least fuel and still be consistent with safe operating procedures. The assumption is made that the applied thrust must at all times be symmetrical; therefore, engines must be shut down in pairs and propellers must be feathered in pairs.

2.6.1 Engine Operation Within a Single Nacelle

Let the 2 engines be denoted A and B, then

$$\frac{\text{FUEL}}{\text{HR}} = \text{SFC}_{\text{NET}} \text{SHP}_{\text{P}} = \text{SFC}_{\text{A}} \text{SHP}_{\text{A}} + \text{SFC}_{\text{B}} \text{SHP}_{\text{B}}$$

$$\frac{\text{FUEL}}{\text{SHP}_{\textbf{P}} - \text{HR}} = \text{SFC}_{\textbf{NET}} = \text{SFC}_{\textbf{A}} \frac{\text{SHP}_{\textbf{A}}}{\text{SHP}_{\textbf{P}}} + \text{SFC}_{\textbf{B}} \frac{\text{SHP}_{\textbf{B}}}{\text{SHP}_{\textbf{P}}}$$

$$SHP_A + SHP_B = SHP_P$$

let
$$R_A = \frac{SHP_A}{SHP_P}$$
 $R_B = \frac{SHP_B}{SHP_P}$ then, $R_A + R_B = 1.0$

Also,
$$\frac{1}{2}(\% NRP_A) + \frac{1}{2}(\% NRP_B) = \% NRP_P$$
 (3)

$$SPC_{NET} = SFC_A R_A + SFC_B R_B$$
 (4)

$$\frac{R_A}{R_B} = \frac{SHP_A}{SHP_B} = \frac{\% NRP_A}{\% NRP_B}$$
 (5)

Using the specific fuel consumption characteristics of Figure 2, the SFC_{NET} is plotted against % NRPp for various R_A/R_B in Figure 11. It is seen that the operating procedure for minimum fuel occurs when both engines are operated at the same % NRP. Below 50%NRPp the procedure for minimum fuel consumption is to shut down one engine completely, thereby operating the remaining engine at a high % NRP and consequently lower specific fuel consumption.

THE PARE		1 A 1	HILLER HELICOPTERS			
CHECKEN			The A.S. Problem is a second of a second of the second of		MODEL	
APPROVE	р		TO THE PERSON OF	MANAGEMENT CO.		REPORT NO
			CONFI	DUNITIA	L	Figure 1
	o 17					
	.00					
	· · 7					
9 OFCret	.6	\			Operating For Mini	g Procedure
l Consumption,	•5				RA F	.5
Specific Fuel	. 14					1.0
Net :	. 3	Single	Engine <	⇒ 2 Engi	nes	
	.2				20	100
	0	20	70	60	80	100
			% NRI	P		
1						

4.

PREPARED Wa 1911.	(A)E	HILLER HELICOPTERS	PADE 15
CHECKED	7171	Aerodyn mie Analysie depont Fer- Transport Propellopine Study	MODEL L'US
APPROVED	79 W	Contract Nonr 1657 (00)	REPORT NO 114.67

2.6.2 % NRPg - 75-100%

For the total required power falling in the range of 75 to 100% of available power, there are two possible operating procedures:

- 1. Maintain all 8 engines at the same % NRP.
- 2. Maintain one pair of nacelles, say, the outboard at 100%NRP while varying the inboard as required.

To evaluate these two possibilities, the following equations are developed.

Let subscript, i, denote inboard, subscript, o, denote outboard, subscript, 8, denote 8 engine or total.

$$\frac{\text{TOTAL FUEL}}{\text{HR}} = \text{SFC}_{i} \text{SHP}_{i} + \text{SFC}_{o} \text{SHP}_{o}$$

but
$$SHP = \frac{THP}{\eta}$$
; therefore

$$\frac{TOTAL\ FUEL}{HR} = SFC \frac{THP_{\dot{1}}}{\eta_{\dot{1}}} + SFC \frac{THP_{o}}{\eta_{o}}$$
(6)

$$\text{Let } R_i \ = \ \begin{array}{c} \frac{\text{THP}_i}{\eta_i} \\ \frac{\eta_i}{\eta_8} \end{array} \hspace{0.5cm}, \quad R_o \ = \ \begin{array}{c} \frac{\text{THP}_o}{\eta_o} \\ \frac{\eta_o}{\eta_8} \end{array} \hspace{0.5cm} \text{Then,}$$

$$\frac{R_{i}}{R_{0}} = \frac{\frac{THP_{i}}{\eta_{i}}}{\frac{THP_{0}}{\eta_{0}}}$$

$$(7)$$

$$THP_{i} + THP_{o} = THP_{8}$$
 (8)

Combining (7) and (8)

$$\text{THP}_{\text{O}} = \frac{\frac{\eta_{\text{O}}}{\eta_{\text{i}}}}{\frac{R_{\text{i}}}{R_{\text{O}}} + \frac{\eta_{\text{O}}}{\eta_{\text{i}}}}, \quad \text{THP}_{\text{i}} = \frac{\frac{\text{THP}_{8}}{R_{\text{o}}} \frac{R_{\text{i}}}{R_{\text{O}}}}{\frac{R_{\text{i}}}{R_{\text{O}}} + \frac{\eta_{\text{O}}}{\eta_{\text{i}}}}$$

PREPARED	trant	. Alt	HILLER HELICOPTERS	PAGE
CHECKED		,	ransport Propolloriane Story	MODEL 1 1/
APPROVED		34	Contract Nonr 1047 ((*))	REPORT NO 12 2

2.6.2 % NRPP - 75-100% (Continued)

and substituting these in (6)

$$\frac{\text{FUEL}}{\text{THP - HR}} = \frac{\text{SFC}_{i}}{\eta_{i}} \left(\frac{\frac{R_{i}}{R_{o}}}{\frac{R_{i}}{R_{o}} + \frac{\eta_{o}}{\eta_{i}}} \right) + \frac{\text{SFC}_{o}}{\eta_{o}} \left(\frac{\frac{\eta_{o}}{R_{i}} + \frac{\eta_{o}}{\eta_{i}}}{\frac{R_{i}}{R_{o}} + \frac{\eta_{o}}{\eta_{i}}} \right)$$
(9)

From Equation (7) and (8)

$$\frac{\eta_i}{\eta_S} R_i + \frac{\eta_o}{\eta_S} R_o = 1 \tag{10}$$

From Equation (7)

$$\frac{R_{\underline{i}}}{R_{0}} = \frac{\% NRP_{e\underline{i}}}{\% NRP_{e0}}$$
 (11)

Also,

$$\frac{1}{2} \frac{\eta_{i}}{\eta_{8}} \% NRP_{ei} + \frac{1}{2} \frac{\eta_{o}}{\eta_{8}} \% NRP_{eo} = \% NRP_{8}$$
 (12)

Using the above relations the two possible operating procedures evaluated on two representative aircraft (Figure 12). It is seen that the minimum fuel is required when both inboard and outboard nacelles are maintained at the $\underline{\mathsf{same}}$ power (Alternate 1).

Transport Propelloplane Study	PREPARED	NAME Name	DATE	HILL	ER HELICO	PTERS	PAGE 10
CONFIDENTIAL Figure 12.	CHECKED			TITLE Aerody	mamic Analysis	s Report For	MODEL 10/
$W_{H} = 100 \text{ lbs/ft}^{2} \qquad V_{T} = 1000 \text{ FPS}$ 1.6 $R_{I}/R_{O} = 2$ $V_{T} = 900 \text{ FPS}$ $V_{H} = 100 \text{ lbs/ft}^{2} \qquad V_{T} = 900 \text{ FPS}$ $R_{I}/R_{O} = 1$ $R_{I}/R_{O} = 2$ $R_{I}/R_{O} = 1$	APPROVED			Co	ontract Nonr 1	57 (00)	REPORT NO.]
$V_{\rm H} = 100 \; {\rm lbs/ft^2} \qquad V_{\rm T} = 1000 \; {\rm FPS}$ $1.0 \\ 1.1 \\ 1.2 \\ 1.0 \\ $				COMPI	IDFNTIAI	<u>-</u>	Figure 12
$R_{i}/R_{0} = 2$ $R_{i}/R_{0} = 1$		1.8	W _H = 40	lbs/ft ²	V _T = 3	.000 FPS	
1.1 $R_1/R_0 = 2$ $R_1/R_0 = 1$ 1.0 $R_1/R_0 = 1$ $R_1/R_0 = 1$ $R_1/R_0 = 1$ $R_1/R_0 = 1$ $R_1/R_0 = 2$ $R_1/R_0 = 1$ $R_1/R_0 = 2$ $R_1/R_0 = 1$ $R_1/R_$		1.6	1009	£ NRP			
$R_{i}/R_{0} = 1$ $W_{H} = 100 \text{ lbs/ft}^{2} \qquad V_{T} = 900 \text{ FPS}$ $R_{i}/R_{0} = 2$ $R_{i}/R_{0} = 1$		1 /		. 1935	100%	NRP & lb /P.	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	HR				100%	7 1111 & 17/16	021
$W_{\rm H} = 100~{\rm lbs/ft^2}$ $V_{\rm T} = 900~{\rm FPS}$	THE	1.0				• 1	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$.8					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			W _H = 100 1	.bs/ft ²	. V _T = 9	00 F P S	
6 Engines 8 Engines 50 60 70 80 90 100		.6	100% N	RP	-	10 10	1
		.4					
% NRP8		50	60			90	100
				Z	NRP8		

PREPARED	NAME V. HILL	DATE CO.	HILLER HELICOPTERS	PAUL	1.7
CHECKEO		FITE	Acrogmanic Analysis Report for	MODEL	1048
APPROVED		•	Transport Propelloplane Utudy Contract Nonr 1057 (10)	REPORT NO	111,7

2.6.3 % NRP? - 40 to 75%

In this range the following engine operating alternatives exist:

- 1. 8 engines operating at same % NRP.
- 2. 6 engine operation as follows: (Assume 2 outboard engines shut down.)
 - a. All 6 engines at same % NRP, that is, $R_i/R_0 = 2$
 - b. Maintain single outhoard engines at 100% and vary inboard as required.

Equations for 6 engine operation are obtained in similar manner to 2.6.2.

$$\frac{1}{2} \frac{\eta_i}{\eta_g} \% NRP_{ei} + \frac{1}{4} \frac{\eta_o}{\eta_g} \% NRP_{eo} = \% NRP_g$$
 (13)

$$\frac{R_{i}}{R_{o}} = 2 \frac{\% NRP_{ei}}{\% NRP_{eo}}$$
 (14)

Evaluation of the above operating procedures is provided by the same two representative aircraft (Figure 12). Minimum fuel requirements are obtained in this range by operating six engines at the same power (Alternative 2a).

2.6.4 % NRP 50% or Less

From the preceding sections it has been found desirable to shut down engines whenever possible and to operate the remaining ones at the same percent of power. In view of this, then, the possibility of operating 6 or 8 engines in this range may be eliminated. The two remaining alternatives are:

- 1. One pair of propellers feathered, 4 engines in 2 nacelles operating.
- 2. 4 engines in 4 nacelles operating.

PREPARED	(A11	HILLER HELICOPTERS	PALIF 21)
CHECKED	TISEE	Aerodynamic Analysis deport For	MODEL 10/18
		Transport Propelloplane Study	to the territory of the second
APPROVED		Contract Nonr 1057 (00)	REPORT NO 11407

2.6.4 % NRP 50% or Less (Continued)

The apparent advantage of operating half of the propellers at higher power and, hence, higher efficiency must be weighed against the increased drag of the feathered propellers.

From Reference 6 for a three bladed propeller.

$$D = \frac{\rho v^2 Dp^2 T_C}{3}$$

and for a six bladed propeller,

$$\Delta_{\text{THP}_r} = \frac{2Dv}{550}$$
 , or

$$\triangle \text{ THP}_{r} = \frac{2 \rho v^3 D_{P}^2 T_{C}}{3(550)}$$

For evaluating $\mbox{THP}_{\mbox{\bf r}}$ the following conditions are assumed:

- 1. Turbine torque is zero (assumes the use of shutters or vanes); therefore QC = 0, β .75R = 85 , and TC = .008.
- 2. Comparison is made at sea level standard conditions.
- 3. Comparison is made at minimum mission speed of 260 knots.

The expression for \triangle THP $_{r}$ is, then, \triangle THP $_{r}$ = 1.96 D $_{P}^{2}$

The increase in available THP for the same SHP that would result from supplying the required power by one propeller at higher efficiency rather than two at reduced efficiency is listed in the table below for representative aircraft.

Corresponding THP_{r} due to the feathered propeller is also tabulated for comparison.

DREPARED W. 1000	HIL	LER HELICOPTERS	PAGS	21
CHECKED	TITLE Acro	dynamic Analysis Report For	MODEL	1002
	Tra	asport Propelloplane Study		
APPROVED		Contract Nonr 1657 (00)	REPORT NO	114.7

2.6.4 % NRP 50% or Less (Continued)

МН	WG	VΤ	$D_{ extbf{P}}$	\triangle THP $_{ extsf{a}}$	\triangle THP $_{ m r}$
40	40000	800	20.36	1300	810
	80000	to 1000	28.80	2200	1620
100	40000		12.86	300	320
	80000		18.20	7100	645

From the above table there appears to be little advantage in feathering propellers. Furthermore, the selection of the optimum is facilitated and not affected by considering all propellers in operation.

2.6.5 Fuel Consumption

This section provides the method used to calculate fuel consumption with engines operating according to the schedules for minimum fuel of the preceding sections.

$$\frac{\text{TOTAL FUEL}}{\text{HR}} = \text{SFC}_{i} \frac{\text{THP}_{i}}{\eta_{i}} + \text{SFC}_{o} \frac{\text{THP}_{o}}{\eta_{o}}$$
 (15)

2.6.5.1 8 Engine Operation

For a given flight condition the total required THP is evenly divided between inboard and outboard nacelles, thus,

$$\eta_i = \eta_o$$
, and

$$SFC_i = SFC_o$$
; therefore

$$\frac{\text{TOTAL FUEL}}{\text{HR}} = \text{SFC } \frac{\text{THP}_{\textbf{r}}}{\eta}$$

EBEDVATE.	N. A*E	, A, 1	HILLER HELICOPTERS	e o (+ f
SHECKED		T I	Transport Propelly case Study	MODEL 171
APPROVED			Contra J. None (657 (96)	REPORTNO .

2.5.5.1 8 Engine Operation (Continued)

The calculation procedure is, then

- a. Read THP, at the given flight condition (Figure 3 or h).
- b. Read percent of normal rated power of propeller shaft, % NRPp (Figure 7 or 9).
- c. Read n at BIRPp (Figure & or 10).
- d. % NRPe = % NRPp for 8 engine operation. Read SFC
 at NRPe (Figure 2.).

2.6.5.2 6 Engine Operation

The total required THP is not evenly divided between inboard and outboard nacelles; however it is convenient to determine a relationship for total fuel/hr which is independent of individual nacelle operation, hence,

$$\frac{\text{TOTAL FUEL}}{\text{HR}} = \text{SFC} \frac{\text{THP}_r}{\eta_8} \quad \text{where}$$

 THP_r = Total required thrust horsepower

η β = propeller efficiency for β engine operation and is read at the percent of β engine normal rated power. This relation is based on the assumption that

$$\frac{\text{THP}_{r}}{\eta_{8}} = \frac{\text{THP}_{i}}{\eta_{i}} + \frac{\text{THP}_{o}}{\eta_{o}}$$

Although the propellers are operating at different efficiencies, the compensating variation of THP: and THP $_{\rm O}$ is sufficient to make the assumption reasonably valid for the matrix.

SFC = effective specific fuel consumption and is read at

with reference to equation (13) with all 6 engines at the same % NRP.

indfisamf (,	NAME	CAIL.	HILLER HELICOPTERS	PA . (
CHECKED		TITLE	Arrandic Amayors of received	MUDEL	
	•		Transport Propeliculare of enco		
APPROVED			Contract Cour 1017 (60)	REPORT NO	1

2.c.5.2 6 Engine Operation (Continued)

$$\% \text{ MRP}_{e} = \frac{\% \text{ MRP}_{e}}{\frac{1}{2} \frac{\eta_{i}}{\eta_{g}} + \frac{1}{4} \frac{\eta_{o}}{\eta_{g}}}$$

The denominator,

$$\frac{1}{2}\frac{\eta_i}{\eta_\rho} + \frac{1}{4}\frac{\eta_o}{\eta_g} ,$$

when checked over the matrix is found to remain nearly constant at .75.

Fuel/hr is calculated as follows:

- a. Read THPr at the given flight condition (Figure 3 or 4).
- b. Read percent of 8 engine normal rated power, % NRP (Figure 7 or 9).
- c. Read ng at % NRPg (Figure 8 or 10).
- d. Read SFC at $\frac{\%}{.75}$ NRP₈ (Figure 2.).

2.6.5.3 4 Engine Operation

The total required THP is evenly divided between inboard and outboard nacelles, thus,

TOTAL,
$$THP_r = THP_i + THP_o$$
 $\eta_i = \eta_o$ and

 $SFC_i = SFC_o$; therefore

$$\frac{\text{TOTAL FUEL}}{\text{HR}} = \text{SFC } \frac{\text{THP}_{r}}{\eta}$$

	NAME	1 511				
PREPARED	Wan in the			HILLER HELICOPTERS	PAGE	1;
CHECKED	in verse Mar		TITLE	A regularic Analysis Report For	MODEL	1., 1
	A		-:	Transport Propelloplane study		
APPROVED				Sontrart Norr 1657 (00)	REPORT N	111.0

2.6.5.3 h Engine Operation (Continued)

Calculate total fuel/hr as follows:

- a. Read THP_r at the siven flight condition (Figure 3 or 4).
- b. Read percent of normal rated power of propeller shaft, % NRPp (Figure 7 or 9).
- c. Read η at INRPp (Figure 8 or 10).
- d. % NRP_e = $\frac{\% \text{ NRP}_P}{.5}$. Read SFC at % NRP_e (Figure 2).

2.6.6 Engine Operation

The following table summarizes engine operation.

Sea Level Operation

% 8 ENGINE NRP	ENGINE OPERATION	% NRP/ENGINE	% NRP AT WHICH TO READ SFC
100 75	Engines can not be to gear box derati	•	is range due
75 ~ 62 . 5	8 Engines at same % NRP	75 to 62.5	Same as 8 engine % NRP
62.5 - 56.2	6 Engine Operation	4 engines @ 7% 2 engines @ 100 to 75%	% NRP8 •75
56.2 to 50	6 engines at same % NRP	6 engines- 75 to 67%	% NRP ₈
50 or less	4 engines at same % NRP All propellers operating	4 engines - 100% or less	% NRP ₈

PHEPARED	NAME	(1411	HILLER HELICOPTERS	PAGE
CHECKED			THE Acrowner Frages Associate	יום וו
		•	Analysis Pro Filt grane Stray	to the specific place and the
APPROVED		1.	Contra t Lour (600 (500)	PEPORTNO ,.

2.6.0 Engine Operation (Continued)

25,000' Operation

% 8 ENGINE NRP	ENGINE OPERATION	% NRP/ENGINE	% NRP AT WHICH TO READ SFC
100 - 75	& engines at same % NRP	100 - 75	Same as 8 engine % NRP
75 - 50	6 engines at same % NRP	75 - 50	8 Engine % NRP •75
50 or less	4 engines at same % NRP All propellers operating	50 or less	8 Engine , AP

2.7 Rate of Climb

Rate of climb is obtained from the expression:

$$\frac{R}{C} = \frac{33000}{W_G} \quad (THP_a \cdot THP_r) \tag{1.6}$$

Figure (13) is a graphical solution of equation (16) for rapid calculation of rate of climb. The maximum rate of climb is obtained at the velocity where the difference between THP_a and THP_r is greatest.

2.8 Rate of Descent

Equation (17) defines airplane rate of descent with power on.

$$\frac{R}{D} = \frac{33000}{W_r} \left(THP_r - THP_a \right) \tag{17}$$

PREPARED	CIAIE	HILLER HELICOPTERS	PAGE
CHECKED		Time + 1 Time to 1	MODEL
APPROVED		Mar of the delical of the state	REPORT NO
o r syriding		Thresh Handson Thresh Thresh Handson Thresh Thresh Handson Thresh	The last Harmon proves August wide Talley
		Cocco (Toco)	6000 1000 7000 5

NAME PARE (A 1 t	HILLER HELICOPTERS	eke.i
CHECKED	11.1	f = A + a + a + b + b + b + b + b + b + b + b	
APPROVED	•	the professional results of the contract to th	REPORTNO

2.9 Installed Hors power

The sea level installed fors power out to readily set rained of the ratio

Boa Level Propellor Thrust
Hover ceiling altitude propeller thrust + engine jet thrust

Sen Level Propeller Turnst
Gross Weight

is known. This ratio is dependent upon propeller and engine characteristics. For the dual rotating propellers, sas turbine power plants, 60001, 95°F hover ceiling, and matrix under consideration, this ratio was found to remain essentially constant at 1.3.

3.0 SPECIFIED AIRCRAFT PERFORMANCE AND MISSION REQUIREMENTS

The specified aircraft performance and mission requirements are listed below.

- 3.1 Required payload is 5000 lbs. outhound and 4000 lbs. return.
- 3.2 Hover ceiling 6000° , 95° F.
- 3.3 Cruise speed 300 MPH minimum (260 knots).
- 3.4 Mission per Figure 14.

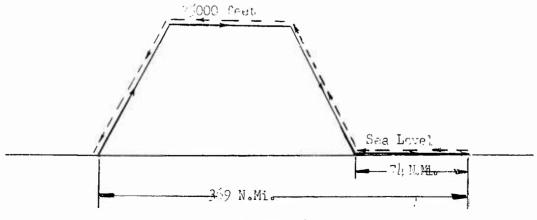


Figure 14.

PREPARED	NAME	CATE	HILLER HELICOPTERS	PALIE
	Wall H.		THELER HELICOTTERS	
CHECKED			THE AMOGNICAL ALLEGA MILLER FOR	MODEL
		1	Tranquit Propelle, ione Study	- 10 to make 10 to 10 to 10 to
APPROVED			Contract None 16^{12} (22)	REPORT NO 1,1,0.

3.5 Total Mission Fuel

To reterrine the total fuel required for the mission, and hence, the "RF", the mission is proken down into component parts. Fuel required for each part is determined, the summation of these providing the total mission fuel.

3.5.1 Starting Fuel

A starting and maneuvering time of 2 minutes per flight leg is assumed, giving a total of 4 minutes. During this time 8 engines are assumed to be operating at 75% NRP. It is further assumed that the operation is at sea level.

$$F_S = SFC(t)(SHP)$$

$$t = \frac{4}{60}$$

SHP = 75% of total installed power

$$F_3 = .0287 SHP$$

3.5.2 Reserve Fuel

Reserve fuel is assumed to be 10% of total fuel.

3.5.3 Climb Fuel

The following assumptions are made regarding climb fuel.

- a. A climb to 25000 feet in the shortest time is assumed most economical.
- b. Rate of climb at sea level is calculated with 8 engines operating at 75% NRP due to sear box derating.
- c. Hate of climb at 25000' is calculated with 8 engines operating at 100% NRP (100% NRP at 25000 feet is equal to 60% sea level NRP, Reference 3).
- d. A linear variation of SHP, SFC, VC, and R/C between sea level and 25000 ft. is assumed.

PRECAREC	Park M. E. A. F.	HILLER HELICOPTERS	BALLE
CHECKED		Term of the Arms o	MODEL
APPROVED			PEPURT NO .

3.5.3 Ultra rad (Contract)

hae, to died tribe city to a stated as foll was

$$F_{C} = \frac{1}{R_{C}} \frac{SFC}{V_{C}} \frac{SHP}{V_{C}} = \frac{V_{C} \triangle H}{SC} = \frac{V_{C} \triangle H}{SC} = \frac{1}{C}$$

V_G = average climb velocity between S.L. and 25000 feet for maximum rate of climb.

Ro = Range credit during climb.

 \triangle H = 25000 feet.

 $\frac{R}{C}$ * Average rate of climb between S.L. and 25000* (Reference to Section 2.7)

SHP = Average SMP tetween S.L. and 250001.

SFC = Average SFC between S.L. and 25000%.

3.5.4 Descent Fuel

Calculation of descent fuel is based on the following assumptions.

- a. date of descent, R/D, is constant at 2500 ft min.
- b. Descent velocity, $V_{D_{\rm f}}$ = 300 kmots.
- . Most economical engine operation per section 2.6 is assumed.
- d. A linear variation of SHP, and SFC between 25000° and S.L. is assumed.

$$F_{D} = R_{D} \frac{\text{SFC}}{\text{VD}} \text{ SHP where}$$

$$R_{D} = V_{D} \frac{\triangle_{H}}{60 \frac{R}{D}} \qquad V_{D} = 300 \text{ knots}$$

$$\triangle_{H} = 25000^{\circ}$$

$$\frac{R}{D} = 2500 \text{ fi/mir.}$$

i	APPROVED			питярная
	GRECKED .		P	
	CHECKED	•	COLD TO A LAND TO THE STATE OF	март с
	BEDARLU		HILLER HELICOPTERS	PAtie
	i	*, 4 ks k	ATI	

3.5.3 Clima Francisco (Continue)

Facility mind is directling in all stated as four was

$$F_0 = R_0 \frac{SFO}{V_0} SHP = where$$

$$R_0 = \frac{V_0 \triangle H}{50 \frac{R}{C}} = and$$

V_C = average climb velocity between S.L. and 25000 feet for maximum rate of climb.

R_C = Range credit during climb.

 Δ H = 25000 feet.

 $\frac{R}{C}$ - Average rate of climb between S.L. and 25000° (Reference to Section 2.7)

SHP - Average SHP between S.L. and 25000:

SFC = Average SFC between S.L. and 250001.

3.5.4 Descent Fuel

Calculation of descent fuel is based on the following assumptions.

- a. Rate of descent, R.D. is constant at 2500 ft/min.
- b. Descent velocity, $V_{D_{\Sigma}}$ = 300 knots.
- .. Most economical engine operation per section 2.6 is assumed.
- d. A linear variation of SHP, and SFC between 25000: and S.L. is assumed.

$$F_{D} = R_{D} \frac{SFC}{VD} SHP \text{ where}$$

$$R_{D} = V_{D} \frac{\Delta_{H}}{60 \frac{R}{D}} \qquad V_{D} = 300 \text{ knots}$$

$$\Delta.H = 25000^{\circ}$$

 $\frac{R}{D}$ = 2500 ft/min.

PREPARED NO Y	(PATE)	HILLER HELICOPTERS	PAGE
CHECKED		Transfer Production of the	
APPROVED	II.	Surra C. ac (14)	REPORT NO 1116

3.5.4 Descent Fael (Continued)

9p = 7 N.M1

SFC = Average retween .5000 and S.L.

SHP = Average Ecomeen 25000 and S.L. May be obtained from equation (17).

3.5.5 Crussing Fuel - 25,000:

Fuel for 25000: cruise = $\frac{R}{V}$ $\left(\frac{Fuel}{HR}\right)$ where

 $\frac{\text{Fuel}}{\text{HR}}$ is obtained according to Section 2.6.5.

V is cruise velocity. It is selected for minimum fuel/mile, but according to mission requirements, in no case less than 260 knots.

 $R = 245 - R_C (N.Mi)$

3.5.6 Cruising Fuel - Sea Level

Fuel for sea level cruise = $\frac{\hat{R}}{V}$ $\left(\frac{\text{Fuel}}{\text{HR}}\right)$ where

 $\left(\frac{\text{Fuel}}{\text{HR}}\right)$ is obtained according to Section 2.6.5

V is cruise velocity for minimum fuel/mile, and equal to or greater than 260 kmots.

R = 74 N.Mi

3.5.7 Return Half of Mission

The return half of mission is identical to the outbound half except for the gross weight which is reduced by the amount of the fuel used for the first half and $4000~{\rm los.}$ payload. The predominant effect of the lower gross weight is in the reduction of induced drag of which the term "K" (Section 2.4) is a function.

For the purpose of determining outbound fuel requirements for the matrix range of wing loadings and aspect ratio a plot is made of fuel versus "K". Figure (15) is such a curve presented for purposes of illustration. From this curve the half mission fuel can be read for my combination of W/S and AR. Also, from this same curve the return fuel can be read at the new value of "K" for the return half.

PRICE STATE	HILL	ER HELICOPTERS	and the same of the decrease resource of the december and the control of the same of the control of the same of the control of	N. W. Lincoln Edward Co P. M. Edward
THE- RED	THE A		MODEL	
PPROVED	:	really age to the	DESCRIPTION OF THE PROPERTY OF	and a manuscript and a second
			Figure 11 .	
		#: 52 52 52 53 54 54 54 54 54 54 54 54 54 54 54 54 54		
		₩		552
	93			802
				150 K/100C
-1 1				100
	-7 -7	09		50
5500 5500	5000 Half Mission Fuel Lbs.) (, t,	,

PREPARED = W	NAME Value	DAIL	HILLER HELICOPTERS	PAGE
CHECKED			Truck A. To be the Armyons Report for a live law outside	Mader (10), A
APPROVED			Contract hour 1-17 (22)	REPORT NO 11107

1.0 MATRIX

The range of parameters considered is outlined below (Figure 16).

Gross Thrust Aspect Wing Tip Weight Leading Ratio Loading Speed

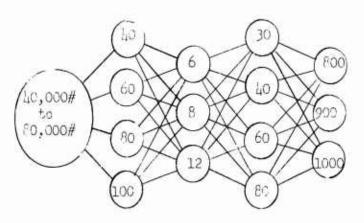


Figure 16.

5.0 MODEL 1048-A, OPTIMUM AIRCRAFT

Physical characteristics and performance of the optimum aircraft are tabulated below.

Gross Weight	71,250 lbs.
Fuel Weight	11,200 lbs.
Empty Weight	51,290 lbs.
Installed Horsepower	8 engines @ 3750 NRP
Disk Loading	65.4 lbs/sq.ft.
Tip Speed	900 ft/sec
Propeller Diameter	18.6 ft.
No. Blades	6
Activity Factor	1 35
Wing Loading	90 lbs/sq.ft.
Aspect Ratio	6.5
Wing Area	792 sq.ft.
Span	71.8 ft.

	NAME	1 A ! (
PREPARED	No Year		HILLER HELICOPTERS	PALLE	
CHECKED		.4	mice Acrestones a style report For	MUDEL	()
		+	Transport Front Lopiner andy		
APPROVED			Contract Honr 1657 (00)	REPURTNO	114.7

5.0 MODEL 1047-A, OPTIMUM AIRCRAFT (Continued)

Stall Speed, Sea Level Standard, Power Off Cruise Speed, Sea Level	300 kts. 350 kts.
Vertical Rate of Climb, 6000:, 95°F, Maximum Power	700 FPM
75% NRP	3700 FPM 6300 FPM liloo FPM 6000 ft.
Maximum Power	
Static Thrust, Sea Level, 75% NRP	85000 lbs.
(Over Gear Box Rating)	102000 lbs.
Power, 2 Engines Out	62800 lbs.
Cruise Altitude, 10% Reserve	2800 N.Mi.

5.1 Power Required

Figure 17 is a plot of shaft horsepower required and available for sea level standard conditions. Power required for the transition region was calculated according to the method provided by Reference (7).

5.2 Jet Thrust

Figure 18 shows the effect of turbine jet thrust on cruising fuel economy. As originally assumed, the difference in fuel consumption is negligible.

5.3 Best Cruise Speed

Figure 18 also shows the velocity for minimum fuel consumption to be 260 knots at sea level and 300 knots at 25,000.

CAGAGERAP	NAME	D. V. I. E.	HILLER HELICOPTERS	PAGE	
CHECKED			TITLE Asynchronic Analysis Report for Transport Propellations Study	MODEL.	1.
APPROVED	Provinces to the province of the second section of the section of the second section of the section		Contract None 1977 (30)	REPORT NO.	<u> </u>
8 Engines (100% NRP) Available		8 Engines (75% NRP) Available	CONFIDENTIAL		i.h '
	c01 X 1	redmreq	bns eldslikvA rawoqeeroM tish2 senign	<u> </u>	
99	56	22	178 178	V	

60-028

PREPARI	ED N	NAME YUUZ.	DATE	THELEN HELIOCHTENS	PAGE
CHECKE	D			Fransport Procelloplane Lody	AODEL 1016
APPRÓVE	ED				EPORT NO. 11/1.7
	38			CONFIDENTIAL Without Jet Thrust	Figure 18.
	3l ₄		X	With Jet Thrust	
.Mi.	30		//		
l Mile Lbs/N.Mi.	22				
Fuel Per Nautical	18	\		With & Without Jet Thrust	Sea Level
	11,			4 Engines	6 Engines 25000 Ft.
	100) FIDEN	150	200 250 Velocity Knots	300

60-028

PREPARED	W. Young	1/1-1 Ó	HILLER HELICOPTERS	PAGE	36
CHECKED	ger administrative confinement and an electric state of the state of t		Transport Propelloplane Study	MODEL	104,8
APPROVED	A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		and the same of the same	REPORTN	0.11/1.7

5.4 Take-Off Distance

Distances required for running take-off to clear a 50 ft. obstacle are provided by Figure 19. The methods of References 8 and 4 were employed and assume a level, smooth concrete runway, sea level standard conditions.

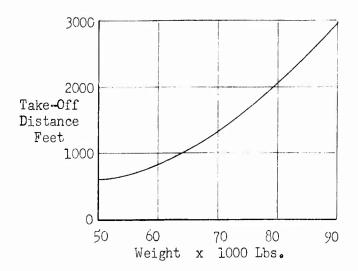


Figure 19.

5.5 Off-Design Operation

Figure 20 shows the range-payload capabilities of this air-craft when fuel and payload are interchanged. Also, as shown, the capabilities are further enhanced when an overloaded running take-off is permitted from home base with a vertical landing and take-off at the remote base.

6.0 MODEL 1048-B

Contract Nonr 1657 (00) was extended an additional period of time in order to establish an aircraft capable of meeting the specified mission and hover ceiling using engines, propellers, and other components available for production in the year 1960.

Two more requirements of the mission were added, namely:

1. Fuel required shall be computed as 2.2 times the fuel required for the first half of the mission. This method of computation is essentially the same as the method used for the main study except that the small reduction in fuel required for the second half due to reduced gross weight is not accounted for.

W. Young Aerodynamic Analysis Report For Transport Propelloplane Study Contract Nonr 1657 (00) Figure 20. CONFIDENTIAL PAYLOAD - RANGE "OPTIMUM" PROPELLOPLANE - VTO Mission - Both Ends Running TO, VTO & Ldg. @ Outbound Base 12 All Missions unload 2 ton payload at 10 outbound base. Last 74 N.M. adjacent to outhound base are flown at sea level cruise at all altutudes at 260 kmots on 4 engines. 8 10 Tons Entire Mission at Sea Level 8 Outbound Payload Altitude Cruise at 25,000 Ft. Altitude Cruise a: 15,000 Ft. 4 0 2 Minimum Payload 0 0 800 200 700 600 1000 N. Miles Radius Action

PREPAR(D	NAME Wa ICUM	DATE ()		HILLER HELICOPTERS	PAGE	'n
CHECKED			TITLE	Acrodynamic Analysis Report For	MODEL	10118
APPROVED	**************************************			Transport Propelloplane Study Contract Nonr 1657 (00)	REPORT	10 11/1.7

e.0 MODEL 1048-B (Continued)

2. The specific fuel consumption shall be increased 5% over the manufacturer's guaranteed value.

Mission and hover ceiling requirements are met by the use of water-alcohol injection for the initial take-off. The aircraft reaches design gross weight of 93000 lbs. for the first landing at the remote base.

The following tabulation lists the physical characteristics and performance.

Take-Off Gross Weight Design Gross Weight Fuel Weight Disk Loading Wing Loading Propeller Diameter No. Blades Activity Factor Tip Speed Aspect Ratio Wing Area Span	= 101,000 lbs. = 93,000 lbs. = 18,500 lbs. = 64.05 lb/ft ² = 90 lb/ft ² = 21.5 ft = 6 (Dua = 135/Blade = 900 FPS = 6.5 = 1032 ft ² = 81.9 ft.
Water-Alcohol	= 1450 lbs. = 125 knots = 270 knots = 300 knots = 365 knots = 465 knots = 6860 FPM = 5800 FPM
Hover @ 6000 ft., 95°F, Take-Off Gross Weight requiravailable power + water/alcohol injection.	es 76% maximum
Hover Ceiling, Standard Atmosphere, Maximum Power + Water/Alcohol Injection Service Ceiling, NRP, Wg Static Thrust, S.L., 75% NRP Static Thrust, S.L., 100% NRP	= 18,650 ft. = 49,200 ft. = 106,300 lbs. = 127,000 lbs.

PREPARED No 10	III		HILLER HELICOPTERS	PALIF
CHECKED		TITLE	Aerodynami : Arrany is segart Por	MODEL SELP
	•		Transport Prop Hoplane State	THE RESIDENCE OF PERSONS ASSESSED FOR STREET,
APPROVED			Contract Nonr LGC7 (*)	REPORT NO 171

6.0 MODEL 1048-B (Continued)

Static Thrust, 6000 ft., 95°F, Maximum Power,	
2 Engines Out	
With Water/Alcohol Injection Added	
Vertical R/C, 6000 ft., 95°F, Maximum Power,	
+ Water/Alcohol Injection, WT.O	
Vertical R/C, S.L., 75% NRP, Take-Off Wg = 1,520 FPM	
Ferry Range @ 20% Overload, 25000 ft Cruise	
Altitude, 10% Reserve	٥

7.0 MODEL 1048-D

A brief investigation was made as to the type of mission that could be made with Model 1048-A using presently available engines and propellers.

As specified, 20 percent of the mission is flown at sea level. With a 6000 lb. payload a mission radius of 270 N.Mi. can be flown. Hot Day (95°F) hover ceiling of 6000 feet is met with the use of water/alcohol injection for the initial take-off and for the first landing at the remote base.

On the other hand, the specified mission radius of 369 N.Mi. with 8000 lbs. payload can be met if the hover ceiling is reduced to 6200 feet standard altitude.

The following tabulation lists the characteristics of Model 1048-D.

Take-Off Gross We	igl	ıt	٥	0	•	0	۰	•			٥	•	•	0	•	•	•		c	=	83,600 lbs.
Engines - 8 Allis	on	50)]-	- D8	} (c	<u>)</u>	331	16/	Er	ıgi	ne	,	S.	L.	,	N	RP	۰			
																				22	71250 lbs.
															•	0	•	0	•	=	6200 ft.
	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Payload	Weight @ First Landing

PREPARED	NAME Wa Yoru.	(147)	HILLER HELICOPTERS	PAGE
CHECKED		TITLE	Aeromiaela Amarus (esti Por Thansha' Proballepiaca Stay	MODEL
APPROVED			Contract Norm 1657 (199)	REPORT NO 14410

Control of the second

7.0 MODEL 1018-D (Continued)

Hover Cerling.... Maximum Power (No Water-Alcohol Injection), Take-Off Gross Weight = 8800 ft.

Hover & 6000 ft., 95°F, Take-Off Gross Weight requires 94% available Maximum Power + H2O/Alcohol Injection.

Ferry Range & 20% overload, 25000 ft. cruise Altitude, 10% Reserve = 12% N.Mi.

The methods used in computing the performance of models 1048-B and 1048-D are identical to those used for Model 1048-A except that the manufacturer's estimated engine performance, including the effects of jet thrust, were used in place of the generalized characteristics of Reference 3.



		N 2 841 A 1		
	PREPARE		HILLER HELICOPTERS	PALE
	CHECKED	•	to be an entire and a second s	
	S	•	The second property of the second	
	APPROVED		Duraci litta (1997)	HEPORT NO. L
12	The state of the s			

TO AN INCLUDE

REFERENCES

- 1. "The ("RF") Graphical Method of Parametric Analysis for the Development of Optimum Preliminary Design Aircraft", Hiller Helicopters Report No. 473.8.
- 2. "Derivation of Weight RF Terms of Parametric Design Analysis for Propelloplane Transport Study Contract Nonr 1657 (99)", Hiller Helicopters Report No. 474.5.
- 3. "Generalized Shaft Turbine Engine Characteristics", Hiller Helicopters Report No. 630.5.
- 4. Wood, K.D., <u>Technical Aerodynamics</u>, Second Edition, McGraw-Hill Book Company, Incorporated, New York.
- 5. "Procedure and Data for Propeller Performance Analysis", Aeroproducts Division, General Motors Corporation, Dayton 1, Ohio, Report No. 190.
- 6. "Wind Tunnel Test of a Non-Rotating Propeller", Report No. C-2560, Curtiss-Wright Corporation, Propeller Division Caldwell, New Jersey.
- 7. "A Simplified Theoretical Investigation of a Wing-Propeller Combination through a Range of Angle-of-Attack from 0° to 90°, II Partial Wake Deflection", Hiller Helicopters Report No. 461.31.
- 8. "The Ground Run of Aircraft in Landing and Take-Off in ICAO Units", Garbell Aeronautical Series No. 3, Garbell Research Foundation, San Francisco, California.

